12-2009

Creating Tomorrow, Fall 2009

College of Engineering

CREATING Tomorrow

COLLEGE OF ENGINEERING

FALL 2009

Bringing home the

GOLD

Utah State University

Dean's Message

The College of Engineering has experienced quite an exciting roller coaster ride this past year. At one moment we would be down as the downward forces of the current economic downturn manifested themselves, and then we would find ourselves pushed to the top of the world as a result of the accomplishments of one or more of our faculty or students. Although we were faced with a modest budget cut, it provided the opportunity for us to plan for our future and refocus efforts and resources toward building a stronger tomorrow.

In spite of these downward forces, the drive and success of faculty and students has created an upward force that has lifted the entire college. This positive force started with the hiring of 16 new faculty members. The enthusiasm and creativity of these new faculty members has already added to research productivity and teaching effectiveness within the college. Research projects pursued by our faculty members and their students are making a difference to the community, state and the world. You will have the opportunity to read about some of these projects later in this magazine.

Perhaps the strongest force that is propelling the college both upward and forward is our students. Not only are we getting the brightest students we have ever had, but they are coming with an attitude that they want to make a difference. A good example is the student team that formed to participate in the NASA rocket competition. Last year they took first place in the nation and were awarded a free trip to watch a shuttle launch. This year that student team was obsessed about defending their title and winning the competition a second year in a row. As you will read later in this magazine, their hard work paid off, and they will be returning to watch another shuttle launch. It is this winning attitude that is moving the entire college forward, and that will also allow our students to become tomorrow's technical leaders.

Finally, despite the ups and downs of the economy and pessimistic views of the future that are dominating the press, I want you to know that there is a place in Logan, Utah, where there are ~2000 engineering students that are looking forward to creating a positive tomorrow!

H. Scott Hinton
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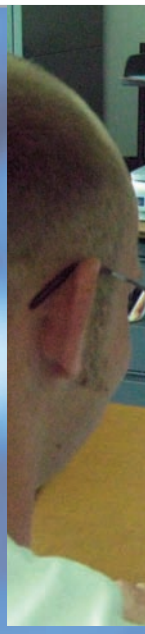

What an Attitude!

Having an attitude isn't always considered a positive characteristic. However, Kathy Bayn's attitude is exactly what sets her apart from the crowd. Bayn, a College of Engineering undergraduate advisor, will be honored at the annual conference of the National Academic Advising Association (NACADA) in October.

"I believe in never saying 'that's not in my job description,'" Bayn says. "I try to learn about ways I can help students—beyond the standard stuff. I tend to be known around campus because I speak up for students in many settings."

It's that attitude that makes the college's graduates and faculty speak highly of Bayn. She shepherds her advisees along the path to graduation from the time they arrive on campus for orientation until they have a firm grasp on their diplomas. That means she is the first to know when course schedules change and what implications the changes have on student progress.

"Any time a student misses a change, it can cost him or her extra classes—even an extra semester," she notes. "I try to do everything in my power to keep that from happening."

Bayn goes the extra mile again by working with high schools and community colleges to make sure courses feed into USU's required coursework; she keeps up on financial aid and scholarship opportunities and directs her advisees to them; and she willingly listens to discouraged students and encourages them to stick it out.

Jim Nottingham (BS'90/MS'92 EE) , Director of Engineering for HP Enterprise LaserJet Printers, believes Bayn helped bring about a positive change in his life.

"I didn't see myself as a college-caliber student," he relates. "After meeting

with Kathy, however, my perception and plans changed significantly. Kathy made me feel like I belonged" and made the academic path seem achievable.

Faculty sing Bayn's praises along with the students. "She incorporates changes made in courses of study..and somehow it becomes embedded in her head," writes ECE Department Head Todd Moon. He adds that they seek Kathy's seal of approval for curriculum changes, knowing Kathy will examine the changes from the viewpoint of impact to students. "Sad experience has shown that if we make changes without her input, we will probably end up changing back!"

Daniel Guy Schauerhamer (BS/MS'07 ME) writes, "Kathy's confidence, professionalism, and quick wit won my trust and admiration when I was a freshman at student orientation. I don't know anyone who can spot an error in a class schedule faster than Kathy. Numerous times I have asked Kathy to review a cover letter, resume, or scholarship application and she has done it every time, putting care and thought into her advice."

That's what we're talking about —ATTITUDE.

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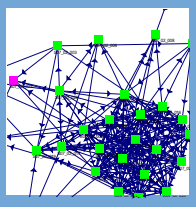

ON THE COVER:
Plane and rocket designers/builders/flyers brought home national titles.

BACK COVER:
Night at the Sant Innovation Building

Where There's Waste *There's* Energy

The BIE Department continues to lead the country in linking water-quality improvement and energy independence through the conversion of algae biomass grown on wastewater into natural gas and biodiesel at the City of Logan Wastewater Reclamation Facility.

Collaboration with Logan isn't novel. Since 2007, biological engineering undergraduate and graduate students and faculty have been collaborating with city employees to develop an Algae Testing and Evaluation Pilot (AT&EP) facility and program at the Logan Wastewater Reclamation facility.

In 2007, *Creating Tomorrow* reported the use of algae in enclosed bioreactors to create biodiesel and take CO_2 out of the air as part of the USTAR-funded USU Biofuels program. USTAR (Utah Science Technology and Research) initiative is a long-term, state-funded investment to strengthen Utah's "knowledge economy."

A new initiative this year uses enclosed bioreactors to studying open pond lagoon systems to produce large quantities of algae biomass for conversion to biofuels, including natural gas and biodiesel, and to fertilizer.

Department Head Ron Sims is a member of the Logan City Water Board that is investigating technologies to remove phosphorus from the wastewater to meet new environmental regulatory

requirements for wastewater discharged to Cutler Reservoir. Since the algae that grow naturally in the lagoon system use phosphorus as a nutrient for growth in the same way other food crops take up nitrogen and phosphorous as fertilizer, Sims proposed harvesting the algae, thus removing much of the phosphorous from the water.

His proposal to Logan City and the Utah Water Research Laboratory (UWRL) resulted in a $250,000 grant to test the ability of the local algae in the 460-acre lagoon system to take up phosphorus present in the wastewater, to evaluate technologies for the separation of the algae biomass from the water, and to test the algae for potential biofuels production.

The Salt Lake City firm WesTech donated pilot-scale units for testing by students. Then in June, the department received a $500,000 grant from the Utah Department of Environmental Quality, Division of Water Quality, to help develop AT&EP facilities to 1) convert ponds to algae raceways, 2) produce natural gas through algae fermentation, and 3) convert algae lipids or oils into biodiesel.

Directed by faculty researchers, students design, build, and test raceway ponds, similar to fish raceways, that are used to increase the concentration of algae in the wastewater that results in an increase in the uptake of phosphorus into the algal biomass. Students separate algae from water using several technologies including filtration, membrane separation, and dissolved air flotation.

"Results generated through the AT&EP facility have applications to all communities in Utah and in the nation that treat wastewater in open ponds or lagoons," Dr. Sims states.

For a complete list of the graduate and undergraduate students and their projects, contact Sims at:
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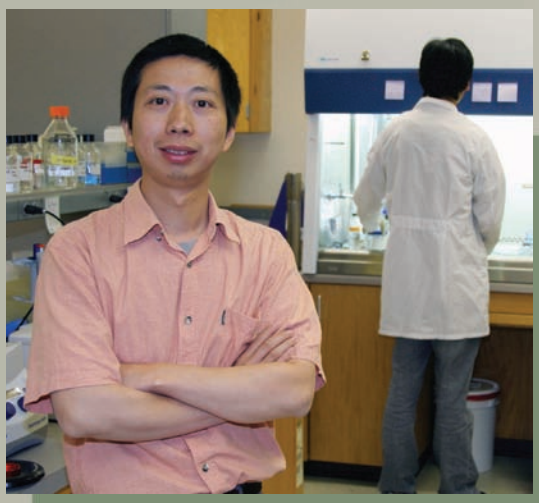
"Drs. Miller and Zhan are strategic hires that will lead the development of an academic program in the new area of Synthetic Biological Engineering (SBE). SBE represents the platform for using biomolecular techniques to create new products and new technologies that have applications in the medical, energy, and environmental sectors of society. Students who graduate with SBE skills are already in the highest demand by industry and academia, and the addition of these new faculty members places USU in the lead in this area."

Ron Sims, Head, BIE Department



R. Hart Evans

Looking for Bioactivity

The Biological and Irrigation Engineering Department opened a Metabolic Engineering Laboratory this year, along with coursework for undergraduate and graduate students, announced Dr. Jixun Zhan, assistant professor and director of the lab.

The research goal of the lab is to engineer biosynthesis of novel bioactive compounds for new drugs. Current projects involve natural products with various biological effects, such as anticancer, antifungal, and anticholesterol activities. The group is studying the biosynthetic pathways of bioactive natural products, characterizing the biosynthetic enzymes, and generating "unnatural" natural products for bioactivity screening. The research in the Metabolic Engineering Laboratory is currently supported by Utah State University and the American Heart Association.

Metabolic engineering techniques are used to engineer the biosynthetic pathways and recombine different biosynthetic genes. All the biosynthesized compounds will be evaluated for their biological activities in collaboration with biologists, including Dr. Paul Shami, an associate professor of Medical Oncology at the Huntsman Cancer Institute on the University of Utah campus.

Zhan offered an undergraduate and a graduate course in metabolic engineering last spring. Students dealt with the fundamentals of cellular metabolic pathways, basic principles of metabolic engineering, metabolic flux analysis, regulation of metabolic pathways, applications of metabolic engineering, and biosynthesis of primary and secondary metabolites. In lab sessions, students conducted experiments, obtained hands-on gene cloning skills and learned genetic engineering techniques which are often used to manipulate metabolic pathways.

This summer, Zhan recognized the value of cultivating young and talented future scientists by selecting a group of qualified high school students from throughout Utah to participate in hands-on laboratory applications and gain valuable laboratory experience as part of the Biological Engineering Summer Internship Program.

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R. Hart Evans

Making Biology Easier to Engineer

A new area of coursework is being developed in the Biological and Irrigation Engineering (BIE) department called synthetic biological engineering (SBE). Synthetic biological engineering is an approach meant to make biology easier to engineer.

For the past several years biotechnology has included recombinant DNA technologies, polymerase chain reaction (PCR) amplification of DNA, and automated sequencing. SBE adds automated DNA construction, standards to define how DNA is put together, and abstraction to hide biological complexity. SBE allows for the design and management of various biological systems in a rational and systematic manner.

In spring 2009, the department offered a new SBE course that gave undergraduate and graduate students an overview of molecular biology and molecular cloning techniques, including PCR and analysis of nucleic acids and proteins. In addition, they were introduced to bioinformatics and the practical use of these programs for biological design, and learned how to use standard biological parts, gene probes, and biosensors.

An example of the use of SBE is in the management of a natural bioreactor. BIE professors and students are managing the City of Logan's 460-acre wastewater treatment lagoons as an "algae farm" to optimize production of biofuels. Besides using various processing methods to generate oil, biodiesel, and compressed natural gas, BIE researchers are using synthetic biological engineering tools to explore the genetics of the biological system. By determining the diversity of organisms in the lagoons, specific microbes can be correlated with particular environmental conditions, as well as being identified as the most beneficial for biofuel production.

BIE Assistant Professor Charles Miller and his team are using a metagenomic approach to characterize the microbial communities of the Logan lagoons. They isolate DNA from water samples and amplify certain regions of the DNA using a technique called polymerase chain reaction (PCR). Reading the genetic code of these PCR products will allow them to determine the identity of the microbial inhabitants. Using this approach, they hope to identify microbes with unique characteristics that may eventually be capitalized on to improve the production of biofuels or other bioproducts.

Once identified, these unique microbes could be augmented in the lagoons or cultured in the laboratory for use in bioreactors. By correlating the overall diversity and distribution of microbes, including algae and photosynthetic bacteria, with the nutrient profiles at various locations, they hope to better manage the Logan lagoons for optimal production of biofuels and nutrient removal.

Students have been very much involved in every facet in the wastewater research since 2006. Two years later they were ready to pit their knowledge of synthetic biological engineering against international competitors.

A team of nine students, mentored by three BIE faculty members, participated in the 2008 iGEM (International Genetically Engineered Machine) competition at the Massachusetts Institute of Technology. They received a Bronze Medal for their first competitive effort.

iGEM's challenge to the competitors was to use biobricks (a standard for interchangeable biological parts to help build systems in living cells) to produce a functional machine. USU's team designed and built biobricks to produce and analyze bioplastics.

The 2009 iGEM team is developing a broad-host range biobrick vector. This DNA vector is needed so that the biobrick format can be applied to other bacteria besides just E.coli.

There are 14 students on this year's USU iGEM team, mentored by professors Charles Miller, Ron Sims, and Scott Hinton. Students include Sky View High School students Tyrel Rupp, Sean Bedingfield, and Garrett Hinton; Intech High School students Jeff Karren and Jody Jerez; Logan High School student Matt Sims; USU undergraduates Alex Hatch, Cole Peterson, Amanda Feldt, and Rachel Porter; and USU graduate students Elisabeth Linton, Trent Mortensen and Brad Henrie. The 14th participant is Hyun Jin Kim, a visiting high school student from South Korea.

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USU Students Carry the Day

Biological engineering students were definitely overrepresented on the winners' podium at the national conference of the Institute of Biological Engineering in March. Of the nine awards offered in student categories, USU students brought home five.

Two hundred attendees from 40 national and international universities, private industry, and federal government units participated through platform and poster presentations held in San Jose, California.

Financial support to attend the conference came from the Graduate Student Senate, the Office of the Vice President for Research, the Biological Engineering program, individual faculty advisors and mentors, and the students themselves who paid for their own food!

In the Undergraduate Student Poster competition, Sara Bailey won second place with "Strategies for Nutrient Removal from Municipal Wastewater and Biodiesel Production through Controlled Algae Growth;" and Eric Monson and Andrew Vanderwerf took third place with "Novel Copy Number Variation (CNV) Detection Methodology for Complement Genes C4A and C4B Utilizing SYBR Green Dye Chemistry." Bailey is mentored by Drs. Sridhar Viamajala and Ronald Sims; the other students are mentored by Dr. Anthony Tores.

Graduate Student Poster competition winners included Elisabeth Linton and Trent Mortensen who won first place with "Efficient Systems for Monitoring and Recovering Polyhydroxyalkanoates" and Mortensen also taking third place with "Inhibitory Effectiveness of St.-Johns-Wort-Derived Compounds Against Mycobacterial Isolates." These students are mentored by Drs. Charles Miller and Sims, and Dean H. Scott Hinton.

Kirsten Sims placed third in the Bioethics Essay competition. (See adjacent story.)

Trent Mortensen

Eric Monson

Sara Bailey

Elizabeth Linton

Andrew Vanderwerf

Not Your Average Grad Student

Academic year 2008-2009 was a busy one for master's student Kirsten Sims. Between classes, thesis research, and reading her winning essay at a national conference, Kirsten participated in monthly conference calls to conduct business with fellow members of the National Council of the Institute of Biological Engineering (IBE).

A 2004 graduate of Logan High School and 2008 graduate of Gonzaga University in biology, Sims was immersed in lab work at Utah State by 2005. Her first experience—genetically characterizing three species of mycobacteria--sparked her passion for lab work. She now works in Dr. Sridhar Viamajala's lab probing lignocellulosic biomass, hoping to discover the best pretreatment strategy for conversion to liquid fuel (ethanol).

Viamajala came to USU from the U.S. Department of Energy's National Renewable Research Laboratory in Golden, Colorado. Sims' research is partially funded by a competitive grant from the Center for Integrated Biosystem at USU.

Sims was chosen by IBE to serve a one-year term as the Graduate Councilor. Involved with IBE for three years now, Sims works with the other members of the IBE National Council to promote Biological Engineering research, collaboration, and industry development; and to organize an annual meeting where students, faculty members, and industry representatives meet to share their research (USU took 17 students to the last conference in March).

Far from finally, because there's much we surely don't know about Sims, she was honored with third place (out of 184 entries) in a national bioethics essay competition sponsored by the IBE. She read her essay "The Evolution of Biological Engineering and the Need for a Distinct and Separate Code of Ethics" at the annual meeting of the institute in Santa Clara, California, last March. Sims believes a standardized, distinct code of ethics needs to be developed for the field of biological engineering.

Sims expects to finish her master's program within the next year and gain some industry experience working in biofuel development before pursuing a doctoral degree.

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Pollution Research Shows

WE ALL HAVE ROLE IN REMEDIATION

When Randy Martin joined the CEE faculty in 2000, he observed a winter phenomena that diverted the course of his research. Hanging over Cache Valley day after day, sometimes for weeks, was the murky pall known as The Inversion. The phenomena isn't new; photographs taken in the early 1900s are hazy with the residue from hundreds of wood and coal stoves used for heating and cooking. But today's haze presents many more problems, Martin points out.

It has to do with the size of the particulate floating around our noses. The residue from burning coal, driving automobiles, and raising livestock are the primary components of the ambient fine particulate called PM2.5 that is raising havoc with Cache Valley's air quality. PM2.5 particles are less than or equal to 2.5 micrometers, which is about 1/40th the diameter of a human hair. Turn a dime on its side and you can slice 620 2.5µm discs from it.

"Particulate 2.5µm and smaller can get into lungs' alveoli sacs and inhibit blood-oxygen transfer," Martin explains. "Cache Valley has repeatedly exceeded the Environmental Protection Agency's limits, creating health hazards for residents, particularly infants, the elderly, and people with compromised respiratory systems. The risk of lung cancer and heart disease increase significantly when 2.5 and 10 µm particulate increases."

Since the winter of 2002, Martin has collaborated with Bear River Health Department (BRHD) and the Utah Division of Air Quality (DAQ) to systematically study the valley's pollution: what causes inversions? what is the chemical makeup of the particulate? how can we remediate the problem?

Cache Valley's bowl shape contributes greatly to winter inversion when high pressure aloft traps cold air in the valley. Researchers placed air samplers throughout the valley and found that, with few exceptions, every part of the northern Utah/southern Idaho valley is equally polluted.

The pall is made up of road dust, unburned hydrocarbons, soot, ammonium sulfate, and ammonium nitrate. In Cache Valley, research shows the largest component by far is ammonium nitrate, which is a combination of nitrate products from combustion, primarily from automobiles, and ammonia, mostly attributable to the agri "cultural industry."During an inversion, it's the nitrates that build and mix with the valley's overabundance of ammonia," Martin says. "That mix becomes a solid—ammonium nitrate—and becomes a health issue.

"The most immediate remedy is to not let nitrate be present in the atmosphere," he says with a sardonic grin as he tries to imagine how valley residents would react to an every-other-day driving ban. "We're not at that stage yet, but unless we begin controlling emissions now, draconian measures could become necessary. Mexico City, Rome, Bejing, and London are feeling those restrictions now.

"A vehicle inspection and maintenance program—emissions tests—should be our first step," Martin believes. "In 2007, vehicle miles traveled were projected to double by 2012; the valley population is expected to double by 2030. Our studies show that 25-50 percent of car emissions come from 5-10 percent of the vehicles (depending on the specific pollutant). A mandatory inspection and maintenance program would identify those cars and keep them in better condition longer."

Making a conscious effort to drive fewer miles is something every driver can do, Martin continues. "None of us has the right to affect other people's health. Get over the attitude that you can drive whenever and where-ever you want. Walk, ride the bus, or get out that bicycle hanging from the rafters."

As of this year, the State of Utah requires tanker trucks statewide to have vapor recovery systems. This will help reduce evaporative emissions of volatile organic compounds which enhance the atmospheric photochemical production of particulate and gas-phase pollutants. A possible next step would be to require the same system on gas station pumps.

What's next?

Martin's research with colleagues at BRHD and DAQ is focused on cutting ammonia levels in half by modifying several agricultural practices.

"It looks like we can make some fairly significant improvement with feed modification and waste management," Martin says. "Early results show that a 2 percent decrease in protein in a cow's diet equals roughly a 50 percent reduction in ammonia with no significant decrease in milk or beef production. We believe farmers will actually save feed dollars while playing a role in cleaning the environment.

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SMASH

Lab Has New Home

For a guy who's eyes still light up at thoughts of bombs and firecrackers, being a structural engineer has its perks.

Associate Professor Marv Halling is division head of structural engineering in CEE. For a decade or so, he conducted research at the Systems Materials and Structure Health (SMASH) lab—a fancy name for a World War II-vintage Quonset hut east of the Utah Water Research Lab. That is, until a few years ago when a heavy snow load on the hut's roof conducted its own smash test.

This summer, CEE's structural engineers and their student researchers moved into a new facility on the opposite side of the water lab, a facility that isn't going to go smash in the night any time soon. Floors start with three feet of concrete, followed by four feet of crawl space, and two more feet of concrete, and equally strong walls fitted with hydraulic rams or actuators to react against. For the first time, structures can be pushed from two directions at once. A 20-ton overhead crane does the heavy lifting.

Funds from the College of Engineering, structures lab, and the state were used to build the new lab and the adjacent hydraulics lab. (Read about the hydraulics lab in the UWRL section of this issue.) In total, about $2.5 million were spent on the two buildings and related infrastructure.

Halling says most of the tests he and his colleagues conduct are for the transportation industry. The Utah Department of Transportation (UDOT) recently sent the lab eight girders from a 30-year-old bridge that was replaced. Associate Professor Paul Barr and graduate students Dave Petty and Parry Osborn are getting ready to test the shear strength of the pre-stressed concrete girders.

"Before we try to smash them, we'll wrap the girders in carbon fiber reinforced with polymer," explains Osborn. While the commercial wrap has been used for some years to prevent bending, not much research has been done to test its effectiveness against shear. We will try various methods of wrapping the girders to see if some methods show more promise than others," Petty adds.

Shear is a sudden failure of a structure and, therefore, potentially more dangerous. "There is little warning that a structure is going to shear, unlike one that bends slowly, giving people a chance to remediate or at least evacuate the area," the master's students explain.

"There is a lot to be learned from these old girders," Halling says. "Can we measure the loss of strength caused by corrosion after 30 or more years of service? Will our wrap research give UDOT some effective, cost-saving ways to extend the life of bridges?"

Maybe Halling will be around in 20 years to smash one of the 50-year-old wrapped girders.

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TESTING AMERICA'S BRIDGES

The Long-Term Bridge Program (LTBP) is two years into a five-year contract to monitor bridges across the United States. The contract is designed to take 20 years and USU must bid each five years to continue its work, says Marv Halling, principle investigator on the project and member of the LTBP team that includes Paul Barr, and Kevin Womack.

During Phase One, LTBP will test 10 bridges in the West. The bridges in Utah, California,

FACTOIDS:

- More than 4 million miles of public roads in the United States
- 43 million more registered vehicles than a decade ago
- Average vehicle weight increased 1,000 lbs since 1985
- Number of miles driven doubled since 1980; quadrupled since 1960
- More than 600,000 highway bridges in the United States
- More than 33% are 30-49 years old
- An additional 30% are 50 years old or older
- 26% of bridges are rated either deficient (does not mean "ready to collapse, just that it needs repair, rehabilitation, or replacement) or functionally obsolete

and Minnesota were selected as statistical samples of bridges of various types and ages in various climate and traffic situations, Halling explains. The testing process, as well as collection and analysis methods will be built into a computer program that eventually will help each state in the nation monitor and manage its bridge inventory.

"We hope to provide improved tools for asset management," Halling says. "In times of limited budgets, states will be better able to stay ahead of the curve to replace or repair—or maximize the use of—its bridges."

The Long-Term Bridge Performance Program is administered through the Center for Advanced Infrastructure and Transportation at Rutgers, the State University of New Jersey. Academic partners are USU, University of Virginia, and Virginia Tech.

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WATER DESIGN TEAM

CEE's one-year-old Water Design Team is headed to Orlando in mid-October to take part in national competition. The team's venture is the result of several individuals and several companies.

First, Andrew Hobson, a senior environmental engineering major, used his passion for networking and organizing to reactivate the Society of Environmental Engineering Student chapter by finding a competition that would motivate a diverse group of students to connect and collaborate.

"I had schoolwork down pat," Hobson explains. "I had a 4.0 grade point average running; but, I didn't know the people sitting around me in classes. I wanted to know people."

Second, Carollo Engineers employee Clint Rogers (BS, MS 2007) heard about the endeavor and put Hobson in touch with the Water Environment Association of Utah (WEAU), the state affiliate of the global Water Environment Federation.

Third, WEAU, in turn, put the team in touch with Dennis Gunn, operator of the Coalville City Water Reclamation Plant.

Fourth, Gunn offered the city's water reclamation expansion project as a design problem for the competition. The challenge: to raise capacity, lower nutrient levels, and improve solids handling, all on the same footprint as the existing plant.

Ironically, this project involved a topic that not one of the team members had yet studied in class. "I remember passing Dr. Ryan Dupont's office on my way to the first meeting of the Water Design Team," Hobson recalls. "I poked my head in his office and asked for some advice. I left with a cart-load of books that I divided among the team members and said 'Start reading!'"

Teams members Allia Abur, Lonnie Brown, Kathita Chittaladakorn, Jon Farrell, Anna Gentry, Dustin Hansen, Hobson, Nakita Horrell, Oscar Marquina, Ariel Nunez, and Lindsey Stevens actually came up with three designs, dubbed The Mercedes, The Buick, and The Volkswagen.

Reliable design and attention to cost brought *The Buick* to the top. "It's a widely used model with a solids contact clarifier which chemically treats the phosphorus to standard. The team improved solids handling by adding a vacuum filter press, removed some drying beds, and improved the existing infrastructure. The design was presented to a panel of judges comprised of wastewater treatment plant operators, equipment vendors, and consulting engineers.

Coalville plant operator Gunn says, "The students did a great job. The solutions they explored were good ones and the one they recommended is most likely the one we will use. These students thought 'outside the box' and that's where new and innovative solutions come from. They will be very competitive and represent WEAU very well in Orlando."

Team member Anna Gentry adds that she "already knew how to go to school," she says, "so it was great to finally be part of one of those opportunities that college is supposed to be about—getting to know fellow engineers and working with professors to solve a real problem."

"For a team that planned to just test the waters this first year, getting an all-expense paid trip to Orlando (thanks to WEAU) in October certainly exceeds expectations," Hobson revels. "We also built unity and character among team members, we developed leadership skills, and we got involved in a global issue."

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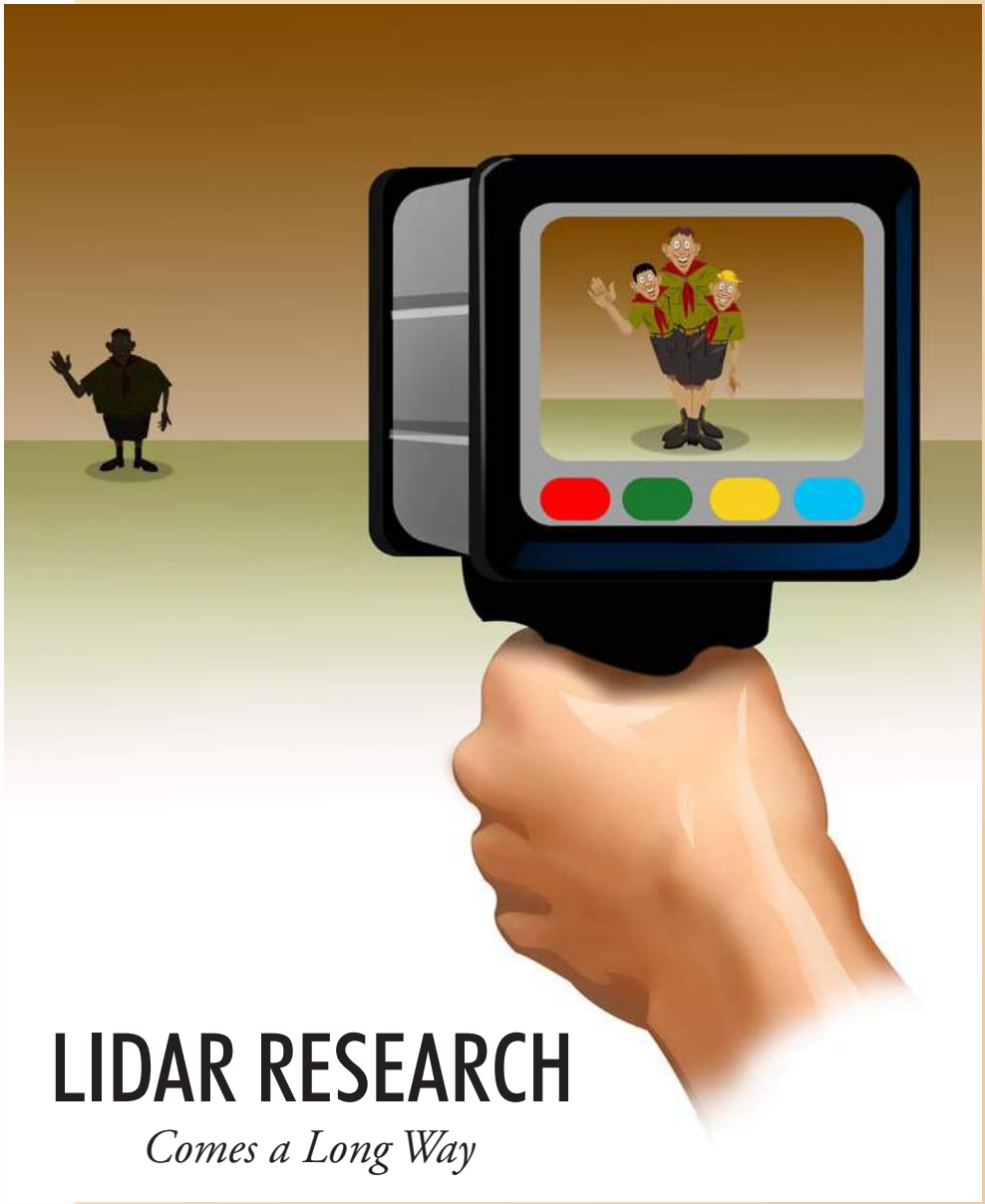
Team members show some of the books they used for the Utah Water Design Competition. Mentor, Ryan Dupont, backs them up.



Shane Larson

LIDAR RESEARCH

Comes a Long Way

LIDAR (LIght Detection And Ranging) research has flourished at USU since the mid-90s. Today, six professors and three students devote much of their summer and out-of-class hours to military and private applications of LIDAR technology.

Major funding for the military-related research comes from the Naval Air Weapons Station (NAVAIR) at China Lake, California. Begun in 2002, the continuous contract was negotiated by Bob Pack, the entrepreneur-inventor who brought his LIDAR research to USU in 1996, and to the Space Dynamics Lab. NAVAIR's aim (no pun intended) is to improve targeting and object recognition in its autonomous combat and surveillance vehicles. (The military uses the acronym LADAR (LAser Detection And Ranging) rather than LIDAR and the name has been adopted by the USU team.)

A military application with non-military potential has researchers preparing Pack's patented 3-D Texel Camera™ technology for service aboard Utah Transportation (UTA) buses. The improved view offered by the laser detection (vs. present technology that uses a photograph or video view) can separate an image of a mother holding a baby, or a tightly packed group of boy scouts. The present technology might mistake the mother and child for a larger person or a pregnant woman, or mistake two or three scouts for one chubby Tenderfoot. When counting makes a difference, the improved view may save lives.

UTA has contracted with CAIL, the Center for Advanced Imaging LADAR, to apply this technology to provide a clearer picture of UTA ridership—their numbers and patterns of use. Having such information would allow UTA to fine-tune its routes for efficient service and fare structuring, and, in the case of an accident, to inform emergency crews as to exactly how many people, along with their physical characteristics, were on the bus.

Scott Budge, principal investigator on the UTA project, sees possible applications in homeland security for airports, points of entry, and at nuclear plants, for example. Because LADAR gathers information by sensing distances, not snapping a picture, it is not as sensitive to lighting changes as a video camera is.

Pack, a civil engineer, directs a multidisciplinary crew at CAIL that consists of co-investigators Budge and Paul Israelsen, electrical and computer engineers; and Reese Fullmer, a mechanical and aerospace engineer.

"CAIL's work is a very good example of the fruit of collaborative effort," remarks Budge. "Each of us contributes from a different point of view."

Budge's UTA project began by exploring the military potential of the technology. CAIL graduate students have worked at the China Lake installation every summer for seven years. This year, master's student Kevin Neilsen devotes his energies to VISSTA, the Vehicle Integrated Sensor Suite for Targeting Applications. VISSTA looks like

a camper with a jam-packed sensor unit on top that looks for all the world like a huge white wheel of cheese.

Everything the sensors collect feeds into computers and other instruments inside the van. Fully self-contained, VISTA can travel to remote sites to collect and analyze huge amounts of LADAR and other data in a fashion heretofore unavailable.

Of particular interest to Neilsen and his professors is to take the LADAR technology into phenomenology–literally the study that classifies phenomena present in the LADAR echo return. In LADAR terms, it refers to capturing the entire wave form of the light returning from an object, not just a point cloud. Improving the ability to "see" the shape of an object will improve confidence--whether the operator is human or a computer—that a military target is identified correctly.

The connecting core of technology running through each of these projects is the ever-improving LADAR research originally brought to USU by Bob Pack, Budge reminds us.

EXPANDING COMMERCIAL APPLICATIONS

Research Assistant Professor Paul Israelsen looks mostly at the commercial potential of LIDAR (returning to non-military usage). Beginning this spring, Israelsen took a new position as Division Director at the Energy Dynamics Laboratory (EDL). EDL is a newly formed entity within the USU Research Foundation which was created to focus on the development of transformational energy systems and to create solutions to critical needs at the energy-environment nexus. EDL is developing energy solutions in conjunctions with the Center for Active Sensing and Imaging (CASI), and the USU Energy Lab. Both are USTAR centers.

The technology created by CASI can be used to find optimal locations for wind farms and to provide increased detail and accuracy for weather modeling and forecasting. Wind energy is becoming a promising renewable energy source and the ability to accurately forecast wind resources and to monitor real-time performance are critical to making wind farms economical and successful.

Portable instruments that detect pollution from agricultural sources such as feedlots have been developed by EDL's Atmosphere and Remote Sensing Lab. The device, called Aglite, can provide size and concentration information of airborne particulates over a 20 square mile area in near real-time--literally painting a picture of aerosols found in the atmosphere. This capability is important to the Department of Agriculture in monitoring emissions from farming operations and livestock facilities. It is also valuable to the EPA in helping to determine pollution levels and point sources for pollution. It is currently being applied in the energy industry in monitoring petroleum drilling operations and to quantify reductions in aerosol levels as petroleum companies make efforts to mitigate and improve air quality.

Another effort which has been led by Pack and Israelsen is the development of an airborne LIDAR and visual camera system that has proven valuable in mapping terrain and other structures. The system, called LASSI, is based on an eye-safe laser that can collect data from an aircraft at rates of up to 200,000 shots per second. The LIDAR system is tightly integrated with an HD video camera that overlays color data directly on top of the LIDAR shots.

The first test flights of the system were conducted in November 2007 at the Logan Bluff landslide study area located just to the south of campus.

This sophisticated LASSI terrain and structure mapping system can be employed in many different applications. The data can be used to create topographical representations, structure models, vegetation surveys, texture mapped 3D models, and many other others.

LIDAR has already been used by UDOT to precisely survey the terrain at the 4500 South/I-215 bridge in Salt Lake City. A replacement bridge was prefabricated adjacent to the existing bridge and put into place over one weekend. Drivers were saved from major traffic congestion caused when a bridge has to be rebuilt onsite.

This work was done by Intellisum, a Salt Lake company which has licensed LIDAR technology from CAIL.

The California Department of Transportation calls the technology "the most significant advancement in surveying in 25 years."

Several other innovations are quickly becoming reality and will be discussed in future issues of *Creating Tomorrow.*

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GET REAL TIME POLLUTION UPDATES

Imagine having up-to-the-minute data on air pollution at the intersection you are about to cross. If you have respiratory problems, are elderly, or are walking with an infant, those data could protect your health.

Master's student Cal Coopmans and several of his professors have been doing more than imagining such technology for the past year. They plan to install mobile pollution monitors called SEAL dataloggers on the front of Cache Valley Transit District buses so they can track the location and severity of pollutants in the air. The data would be periodically uploaded to a central server via wifi and made available to the public.

Coopmans' research got a boost of energy last winter when Dr. YangQuan Chen, Director of the Center for Self-Organizing and Intelligent Systems, suggested that his graduate student

form a team and enter the Imagine Cup competition sponsored by Microsoft Corporation. Microsoft promotes the United Nations' Millennium Development Goals to end extreme poverty, hunger, illiteracy, and disease by inviting students to develop solutions.

"Our idea fit well into the U.N.'s fight against disease; we just had to develop the specific system and application in time for the competition," Coopmans says. Along with fellow graduate students Oskar Delgado and Josh Kerkmann, he entered the Software Design Division. Nearly 150 projects were submitted; of those, 110 projects were based on mobile technology, and only 15 were invited to the finals in Cambridge, Mass.

"We created an overall system called FreshPath that works in mobile phones in conjunction with the SEAL dataloggers," Coopmans explains. "If your phone has GPS, you can avoid the worst pollution in real time. The system is practical and can directly help people with respiratory conditions to stay out of particularly polluted areas."

Delgado helped with technical issues while Kerkman, a business major, worked on their presentation and business plan.

"We had a great mentor—Dr. John Johnson, head of the Department of Management Information Systems in the Huntsman College of Business," Coopmans notes. "He really pulled the project together because a large part of the Imagine Cup is nontechnical, business-related presentations, business plans, branding, etc."

"Cal and Oskar represented USU very well in Cambridge," Johnson notes. "Their presentation was excellent. The energy they exhibited was exciting to watch. It was a pleasure to watch their business idea grow as they worked with Josh."

Also helping with lab space, resources, and technical advice were Chen and Dr. Todd Moon, Head of the ECE Department.

"Cal stepped up to the plate and took some real initiative, developing the project, working with business, making a credible presentation. This has been a great experience for Cal, and he has represented us very well," says Moon.

Chen adds, "Dr. Randy Guthrie, Microsoft Academic Relations Manager, has tirelessly helped us to recognize the potential of the Imagine Cup event in students' learning and career-building experience. With help like this, we are no longer isolated to opportunities for academic excellence. Cal's team success again proves that we are great Aggies!"

Traveling to the finals to rub shoulders with bright engineering students and professors from throughout the United States was an unexpected delight for Coopmans and Delgado. Microsoft treated contestants to training sessions on how to create a business; industry and government environmental employees offered encouragement to the designers.

"A woman who works in Boston's environmental office took a lot of interest in our project," Delgado remembers. "Also, we were encouraged to contact an environmental science professor at Harvard to talk about our work."

Coopmans adds, "We had a very warm reception from just about everyone at the Imagine Cup, and several people told us we had the best project they had seen. We had some interest from the public health academic community and everyone encouraged us to keep developing FreshPath."

That kind of encouragement keeps the enthusiasm rolling, Coopmans says. "The business training we received before and during the competition was very interesting to me; I'm considering taking some entrepreneurship classes and possibly pursuing an MBA."

"We'll work on FreshPath and have it ready for next year's competition," Delgado states.

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BRAGGING RIGHTS

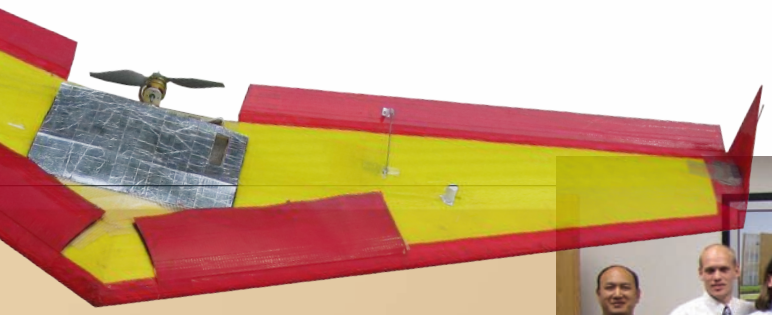
Nine engineering students are still flying high since their miniature unmanned airplane (UAV) blasted international competitors' planes out of the skies over a U.S. Naval base at St. Inigoes, Maryland, this summer.

The competition included 25 teams from around the world.USU is a relative newcomer to the competition, having started last year with a bang by bringing home second place honors.

According to team co-leader Chris Hall, the USU team aced three of the four competition categories—Best Overall, Best Flight, and Best Journal Paper. "We were told that our score was the highest ever given in the seven-year history of the competition," Hall says. "The judges told us that we would have won the Best Test Readiness Review category if we'd remembered to mention one particular thing during our poster presentation."

"So, to put it lightly, we nailed the competition," he continues. "We brought home $14,000 in prize money and international bragging rights.

USU's Open Source Autonomous Miniature (OSAM) UAV team is part of the Center for Self Organizing and Intelligent Systems (CSOIS) and is working in conjunction with the Utah Water Research Laboratory (UWRL). USU-OSAM team designed, built, and flew a



72” wingspan foam delta wing, named Tiger, with modified OSAM Paparazzi Open Source Autopilot for navigation, an Inertial Measurement Unit with GPS for position data, and Canon digital cameras for imaging through a wifi link. The aerial images are sent back to the ground image computer together with the position and orientation information for further image georeferencing and registration.

Images sent to the ground control system are orthorectified (to find the pictures’ geo-coordinates) and placed on a 3D map of the world, where an observer can scan the images for targets. USU’s plane had to be brought back to earth to correct a camera setting and still finished with the fastest time and identified every target (which spelled out Semper Fi #1).

Although the grins haven’t faded, each team member has had time to reflect on what the hard work means to him.

“A number of employers—from NavAir, Boeing, Northrup Grumman, Lockheed, General Atomics, to name a few, as well as small government contractors were at the competition and the awards banquet,” Chris points out. “We were told about lots of opportunities. Employers were especially interested in our team—we were definitely first pick.”

Co-team leader Haiyang Chao thinks the whole idea is fantastic. “We needed to make something work and we did it. We represent the future of unmanned vehicle technology.”

Long Di, who built the model and operated the ground control station, has a larger view of his opportunities. “We proved to ourselves that hard work pays off. We sent a strong message to our classmates about what is possible.”

The whole team is looking toward the future. “We want USU to participate every year and believe we can help the students who take over when we graduate,” remarks Yiding Han.

That is what team alumnus Austin Jensen did. The electrical engineer earned his master’s degree this spring and went to work for the UAV project centered in the Utah Water Research Laboratory. He meets regularly with the team and coordinates research that will benefit both the competitors and his project at the water lab.

Chao adds that working together, for thousands of hours over the last two years creates a bond, a cohesiveness, that will last many years.

The rest of the team members are Calvin Coopmans, Daniel Morgan, Kaylon Anderson, Aaron Avery, and Jeff Anderson. Dr. YangQuan Chen, Director of the Center for Self-Organizing and Intelligent Systems and team advisor, says the students worked extremely well and with constant input from him. “Mostly, I made coffee for the meetings,” he quips.

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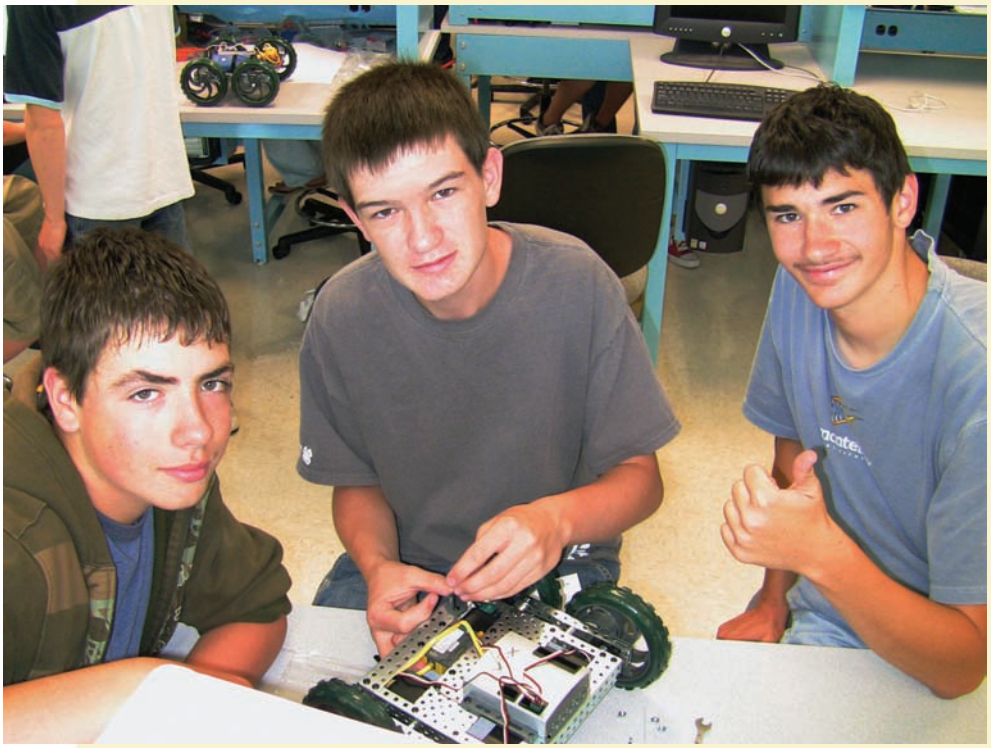
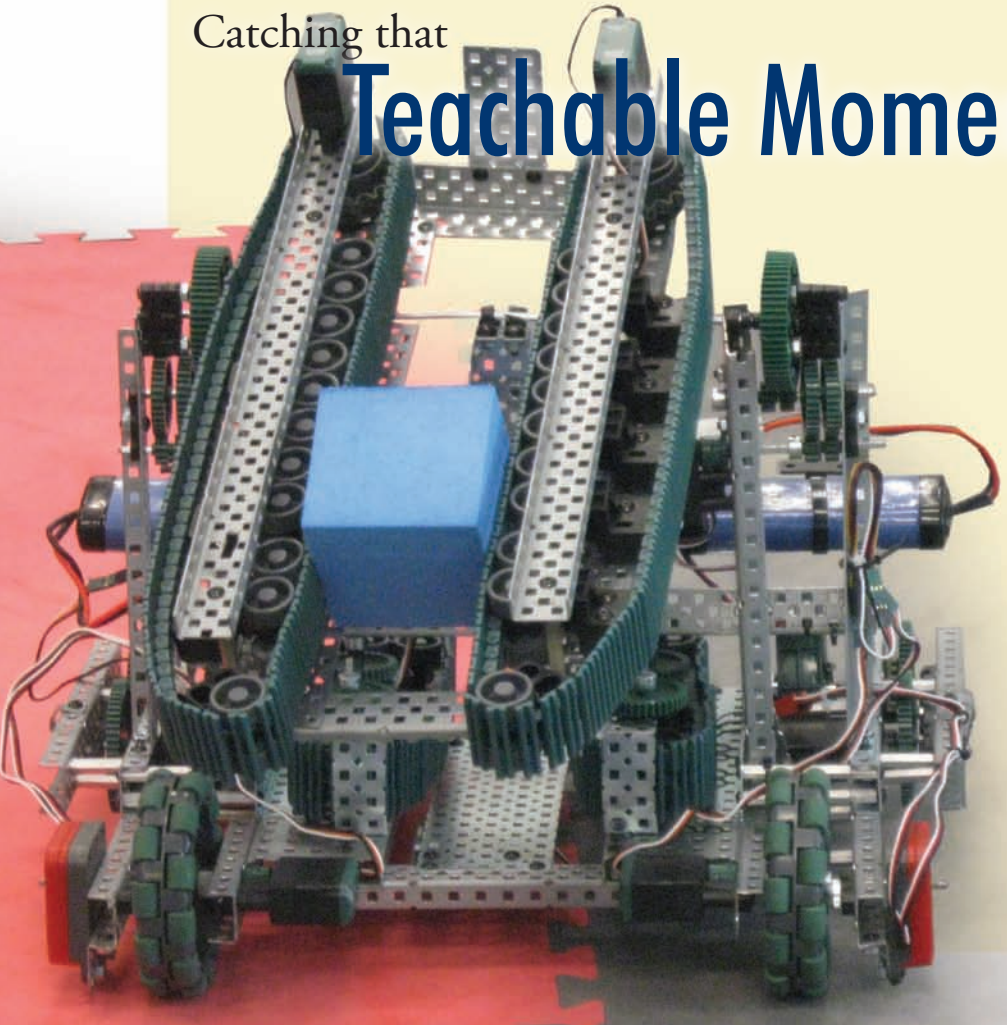


Catching that Teachable Moment



Have you watched a teenager text message lately? Their thumbs are a blur tapping at the tiny cell phone keys. Adults are hard pressed to remember to triple tap for a "c" or to find the question mark. Teens embrace new technology the way their parents embraced telephone answering machines.

The same scenario applies to robotics today, says Dr. Gary Stewardson, an ETE associate professor who mentored USU's first team to compete in VEX competition. VEX is a mark of Innovation First International, sponsor of the international competition that culminated May 2 in Dallas, Texas.

Fourteen countries (more than 30 teams alone from China) sent some 300 elite VEX teams from middle school, high school, and universities to compete in "two days of non-stop pulse-pounding robotics challenges," one press report proclaimed.

"I think it's fair to say that most young people are more comfortable with electronics and robotic technology than are most adults," Stewardson says. "Students get very excited when competing with robots they have designed, built, and programmed. Teachers need to channel that youthful enthusiasm into projects such as VEX. They need in-service training to help them take advantage of this teachable moment."

"One of the responsibilities of our department is to train teachers," Stewardson states.

"Practicing technology and engineering teachers and teachers preparing to enter technology and engineering classroom must have the skills to lead their students into competitions such as VEX. In other words, we're telling them to warm up their texting fingers and learn with us!"

Doctoral student Steve Williams taught middle school technology education in Omaha, Neb., for five years before returning to his Aggie alma mater to complete a master's and PhD. He coached his students in similar competitions and saw how enthusiastic

they were, knowing they would pit their robot against others.

Jason Morrella, senior director of education and VEX competition for Innovation First International, adds, "We are committed to providing opportunities such as this worldwide competition to further motivate kids to be passionate about science and technology. The tournament was designed as a vehicle for students to develop critical life skills such as teamwork, leadership, and project management, honed through building robots and competing with like-minded students from around the world in a fun, non-traditional environment."

One thing the USU team liked about the competition was that every team began with the same basic VEX robotics design system. "Everyone started out on an even playing field," Stewardson says. "After that, schools with bigger budgets could buy VEX peripherals, but, for the most part, teams won because their programming skills and strategic thinking were superior."

Each year the playing field changes—this year, the competition was called "Elevation" and required robots to stack cubes in goals spaced around a 12' by 12' arena, Stewardson explains. "Next year's competition is called 'Clean Sweep;' we don't know yet exactly what the robots will be required to do, but the arena will stay the same and the components bought for this year's competition will make next year's robots."

Keeping costs down is vital to a school's ability to compete year after year. Dean Scott Hinton funded the Technology and Engineering Education Club's request for $5,000 to gear up for their initial year of competition. Team members were excited when they were seeded third after the qualifying round. They returned to campus motivated to improve their design and push through to a top placement in future competitions.

CREATING A DESIGN ACADEMY: PARTNERING WITH 4-H CLUBS

Stewardson, Williams, and colleagues in ETE plan to generate more interest in robots competitions with the development of a Design Academy at USU. Students in the region (grades 5–12) will be invited to attend the academy twice a week during the school year to design, build, and program robots using VEX and LEGO components, then compete in a regional competition on campus hosted by USU in January. The region winner in the VEX competition will advance to international competition. USU's Development Office is searching for funds to help get the academy off the ground with hardware and travel expenses.

A partnership between the ETE department and Utah's 4-H program will greatly assist in the development of the Design Academy and the hosting a successful and well-attended regional competition. 4-H has had a rich history in hosting LEGO robot workshops and events throughout Utah. By partnering with 4-H we are able to build on their success with LEGO robotics while introducing VEX robotics to the region.

In July, with the support of 4-H, the ETE department ran a two-and-a-half day workshop to train students and their mentors or teachers how to design, build, and program VEX robots. Each team left the workshop with a VEX robot kit, a new set of skills and the confidence to compete. Hopefully each team will return in January and compete.

The partnership was created by Stewardson and Dave Francis, the Youth Development Specialist for science, engineering, and technology at Thanksgiving Point Extension office.

"While many youth and adults think of 4-H as 'cows and cookies,' the organization has excellent resources and capacity to involve youth in informal science, engineering and technology (SET) experiences," Francis comments. "4-H youth have been engaged in university-based research and demonstration projects for over 100 years—helping bring innovation and understanding to local communities.

"Working with the ETE department has opened doors to support our robotics efforts, Francis adds. "Dr. Stewardson and students provide much-needed expertise and training to youth from around the state." For more information, go to http://4-h.org/programs_mission_mandates/set.html. Funds to support 4-H participation come from the Utah Governor's Office of Economic Development (GOED) specifically through the WIRED Initiative: http://business.utah.gov/programs/state-science-advisor/wired/.

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DOES SOCIAL NETWORKING AID ABILITY TO LEARN?

In addition to training the next cohort of America's technology and engineering teachers, the Department of Engineering and Technology Education is creating education designs that do a better job of motivating and educating students.

Could social networking improve a student's ability to learn?

ETE Assistant Professor Paul Schreuders' premise is that our ability to function depends on our interactions with groups and individuals around us. So how do groups and individuals in a classroom impact a student's ability to learn and perform well in class?

He began several years ago to collect very specific data from students in engineering classrooms. He wants to know how close students are to one another—in large and small classes, who are the students with the most friends (defined as having a relationship in class), and if there is a statistical correlation between closeness and good grades.

Certain facts became clear: 1) the more friends you have, the more friends you are likely to make; 2) students get together outside class to work on homework; 3) what John Guare popularized in his play "Six Degrees of Separation," students can do in three degrees; and 4) students who perform better in class tend to have larger social networks and, inversely, students who perform poorly in class tend to be more isolated.

"That doesn't mean that if you're isolated, you'll do poorly," Schreuders cautions, "it just means you aren't tied into the help offered by fellow students."

How can teachers use this information?

"Once we understand how these interactions impact performance, the goal is to improve the appropriate kinds of interactions so that everyone can take advantage of the network," he says. "The next step in my research is to determine which relationships are the most beneficial and figure out how to promote that behavior in all students."

The educator points out that his research has very interesting implications for the business world as well. "Business managers want to how to get people to perform better," he notes. "They need to identify the person or persons in the organization to whom other employees turn for help. When you find out who that is in your business, you take steps to retain him or her and to cross train other employees with that top networker."

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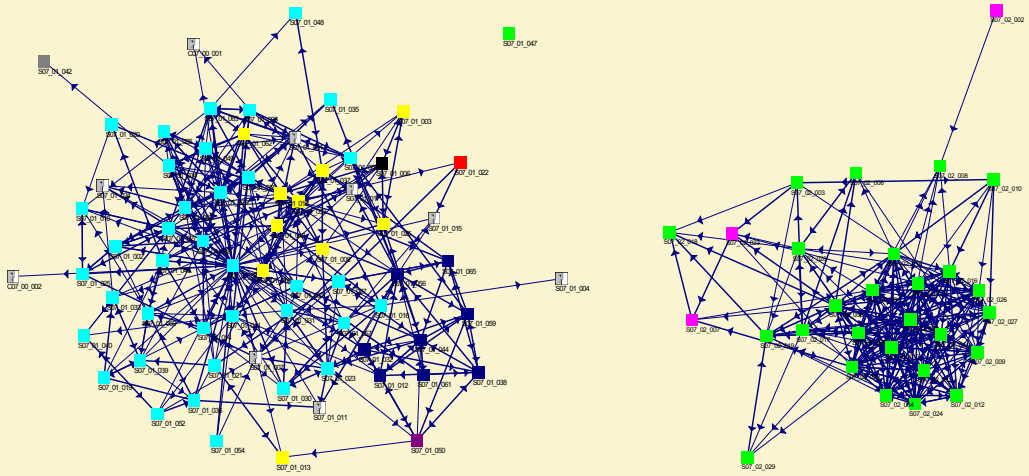

The informal social networks in two electrical engineering for nonmajors classes. The graphs show the tendency of the students to group with others of the same major.

Shane Larson

NEW PHD: PRODUCE BETTER ENGINEERS

Utah State University started a new PhD program in engineering education this fall.

USU joins Purdue and Virginia Tech as the only universities in the nation to offer PhD programs in engineering education. Some universities with engineering education programs offer certificates.

Purdue is the first of the schools to produce graduates in this area, Virginia Tech has candidates who will finish in 2010, and USU anticipates its first graduates in 2012, reports Engineering and Technology Education (ETE) Department Head Kurt Becker.

"All three universities are fairly aligned in the way that their programs are structured," Becker says, each realizing that we need more engineers, scientists, mathematicians, and technologists. "STEM (Science, Technology, Engineering, Mathematics) is the acronym for a national push to engage students in these fields," Becker said.

USU is in the last year of a five-year, $10 million National Science Foundation contract to prepare the next generation of leaders to work in engineering and technology classrooms. Students took curriculum and instruction development courses in the College of Education that were augmented with courses from the College of Engineering that focused on specific engineering skills.

The new engineering education PhD requires students to already have a bachelor's and/or master's degree in an engineering field. These students will be the next—and it is hoped, larger—generation of engineering education researchers. They will concentrate on such topics as: how to assess students in the classroom, how people learn engineering concepts, philosophy of engineering education, and how to acquire research funding for projects.

Becker says he believes the PhD program will grow slowly; it should take students about three years to complete the program.

"Growth comes slowly," he says. "The economy has slowed our growth but we plan to add one more faculty member this year. I anticipate that within five years we will have 15 full-time PhD students in the program to support engineering education research."

Purdue graduates are getting very good positions in research institutions, engineering universities, and colleges with undergraduate engineering programs, and they are working in industry. "We expect the same for our graduates," Becker says. "I also think that it's going to help the engineering profession as a whole. We're advancing the research to better prepare engineering students to learn engineering. That's the bottom line. We want to produce more and better engineers."

In March 2009, Becker received NSF funding to put together a national symposium where engineering deans discussed engineering education opportunities and issues. Among other things, they explored business models for starting an engineering education program.

"That symposium was a success. We stimulated a national dialog on opportunities and challenges for engineering education research and practice in programs throughout the country," Becker reports.

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WE'RE ADVANCING THE RESEARCH TO BETTER PREPARE ENGINEERING STUDENTS TO LEARN ENGINEERING. THAT'S THE BOTTOM LINE. WE WANT TO PRODUCE MORE AND BETTER ENGINEERS.

Professional Ties Give MAE Students Chance at NATIONAL LAB EXPERIENCE

Six of MAE's top students are spending (or have spent) quality time with mentors at the U.S. Department of Energy's Idaho National Lab (INL) in 2008-2009. In addition to their outstanding academic credentials, these students had the reputations and recommendations of Drs. Heng Ban and Barton Smith behind them.

Ban and Smith work closely with scientists at INL and believe their students have much to learn by spending a summer in Idaho Falls. The professors teach thermal-fluid and energy courses at USU and, with other MAE faculty members, are restructuring and fine tuning these courses to meet the needs of the nuclear industry. An academic minor in nuclear energy is planned for the future, Ban says.

"INL has state of the art energy-related research housed in a world-level facility," Ban states. "Our students read the texts, hear the lectures, and study hard, but practice in a real-use situation under the guidance of top scientists will help them putting it all together."

"The nuclear power industry has not been affected by the world economic downturn," Ban says. "Industry and government research dollars keep going up and positions go unfilled because so few students are specializing in nuclear energy."

"Also, the scientists who built America's existing power plants (no new plants have been built in more than 20 years) are retiring," Ban notes. "These aging plants need to be replaced with much more efficient plants. We need trained people to operate and maintain existing plants, plan new ones, and do the research and development on new technology."

"Supplying the United States with sufficient energy is going to require nuclear energy to be part of the national energy mix for the foreseeable future," Ban adds. "Today, nuclear energy is only 20 percent of the power used in the United States. Half of the country's power comes from burning coal, which causes significant problems with carbon dioxide levels in our atmosphere. We need to work hard to add more renewable energy sources to the mix. Presently, renewable sources account for just a few percent of the country's power."

"In addition, industry needs more experts trained in developing materials with advanced mechanical and thermophysical properties, thermal hydraulics, and computer simulation. We have the courses and the expertise to supply those experts," Ban says.

Issues of particular interest to the general public that need research include waste—how to minimize waste, non-proliferation—to make nuclear material unusable for bomb design; and

safety—to build and operate the safest and most efficient power plants possible.

Combine jobs aplenty with starting salaries around $55,000 and average salaries in the $90-125,000 range, and careers in the nuclear industry are very attractive.

Here's what MAE's interns at INL have to say.

Smith's student Jeff Harris says "I've been convinced that the nuclear industry is going to have a bright future with the way energy supply is going... and I didn't want to miss out on the career experience of a lifetime (at least for an undergrad)."

Heather Wampler, Ban's student and a native of southern Idaho, wants to gain engineering experience and find out if she likes the work or it was something she wants to eliminate from her quest.

Another Ban undergraduate, Daniel Garrett, hopes to get a feel for what an engineer does in the real world and see if nuclear is a field of interest to him.

All three students agree that nuclear energy has a role in meeting the world's energy needs; Harris adds that "getting a job in the industry looks like a smart move to me." The three are seniors this fall at USU and all say they plan to earn graduate degrees.

"The experience has made my mind a little divided," Harris says. "I now have to choose if I want to go into fluids or nuclear or materials or aerospace; there are so many choices. From what I can tell, INL has many of those projects. They are not just nuclear research projects."

Although Ban says he has not had former interns in classes as yet, he imagines the summer experiences change their perspectives. "They have used many of the principles in the real world and understand them more deeply," he says.

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Wenbin Yu

Dr. Wenbin Yu, MAE Associate Professor, received the 2009 Research Excellence Award in the College of Engineering.

Yu's research includes theories of composite structures, smart structures, heterogeneous materials, and multibody dynamics. He says his Variational Asymptotical Beam Sectional Analysis (VABS) computer code, "...is a unique tool capable of realistic modeling of initially curved and twisted anisotropic beams with arbitrary sectional topology and materials." VABS is currently being used by academia and industry.

In addition to receiving the Research Excellence Award, Yu was also named the Utah State University 2009 Entrepreneur for his VABS by the Technology Commercialization Office. wenbin.yu@usu.edu

Thomas Fronk

Teacher of the Year: Dr. Thomas Fronk, MAE Associate Professor, received the 2009 Teaching Excellence Award in the College of Engineering.

Fronk teaches theory, but more importantly he teaches the background behind the theory. To go even further, he provides students with opportunities to apply those theories. He is respected for knowing all of his students names and making himself available to them if they need his help. In addition to teaching and research, Fronk has also served as the faculty advisor for the College of Engineering's student chapter of ASME. thfronk@engineering.usu.edu

Yibin Anna Xue

Yibin Anna Xue came to the MAE Department one year ago from a research position in the Center for Advanced Vehicular Systems at Mississippi State University. With BS and MS degrees in applied mechanics and computational mechanics, respectively, from Dalian University of Technology in China, Xue completed her doctoral degree in mechanical engineering at the Georgia Institute of Technology in 1998. Xue is interested in solid mechanics including theories, numerical simulation and experimental evaluations of deformation, fatigue and fracture of metal, polymer, and composites, specifically metal fatigue and polymer-based compositions. anna.xue@usu.edu

Dhirendra Kubair

Dr. Kubair, an assistant professor in MAE focuses his research in computational solid mechanics, particularly computational dynamic fracture mechanics. His present research emphasizes cohesive modeling of dynamic fracture mechanics using novel computational tools such as spectral scheme and cohesive volume finite element schemes. His group is developing a multi-scale modeling framework to understand the process of the direct silicon wafer bonding used to create 3D MEMS structures. kubair@engineering.usu.edu

OH, THAT SWEET SECOND TIME

USU's Rocket Team, Chimaera, brought home top national honors for the sweet second time in as many years from the University Student Launch Initiative. Held in April in Huntsville, Alabama, under the direction of the office of education at Marshall Spaceflight Center, the competition attracted 21 university and 19 high school teams with a grand prize of $5,000.

Once again, Chimaera advisor and aeronautics professor Stephen Whitmore watched the students work as a well-oiled machine to pull off the repeat.

Each team had to design a rocket (with a payload) to fly to an altitude of one mile. If a rocket flew more or less than a mile, the team lost points, Whitmore explained. USU students designed a guidance system to fly their rocket one mile in the air. In the test launch, Pike, as the rocket was named, stopped within 1-meter of mile. At the USLI competition launch, the rocket flew about 30 feet above a mile because of sensor noise, Whitmore said.

"We achieved every single mission objective," says Whitmore. "I can't tell you how many points we won but I can tell you we didn't lose many."

Teams were graded by a panel of NASA and ATK Launch Systems experts on a variety of factors, including design, preparation, launching the rocket, and a final report of flight results.

All together, the team had to do about five or six presentations and four reports. That's not including the presentations Whitmore had team members do to raise money to travel to the competition.

"The competition actually spans a year," the advisor says. "It starts in October as teams apply to NASA to enter the competition. Plans and designs are judged by NASA and about half of the schools that apply are accepted.

"It's worth it to these students to put in the hours, weeks, and months of hard work. The competition makes everything real. If everything isn't just like the textbook, you have to find out why. It helps students get the big picture. You have to test it. You have to measure it," he explains.

It's worth it to Whitmore to watch the students mature, grow in their chosen profession, and gain a much clearer knowledge of procedures.

Whitmore demonstrated many aspects of the rocket systems design as an example in class. "You see a lot of light bulbs go on," said Whitmore. "It was a rare privilege to present classroom lecture material with concepts directly illustrated by data the students themselves had collected."

For his excellence in the classroom, Whitmore was named 2009 Engineering Educator of the Year by the Utah Engineer's Council and represented the state at the American Institute of Aeronautics and Astronautics conference.

The rocket is so sophisticated, and the systems are so diverse that no one person could possibly know everything about it, which required that the students set up a formal systems engineering process to insure that all of the pieces fit together.

"The big thing is the students got to experience what it's like to work on a team in a matter that was identical to what they will experience once they enter the industry workforce. You can't just have a garage project where you can just go and tinker," he warns.

Whitmore pointed out that the students, with the aid of graduate students serving as day-to-day instructors, had to generate the design themselves, which gives them hands-on experience.

"There were quite a few calamities,"

"They'll draw on the hands-on experiences later in their careers," says Whitmore. "For a lot of students, working on Pike was a big deal."

Whitmore's experience at NASA didn't hurt either. "I worked for NASA long enough to know what they're looking for."

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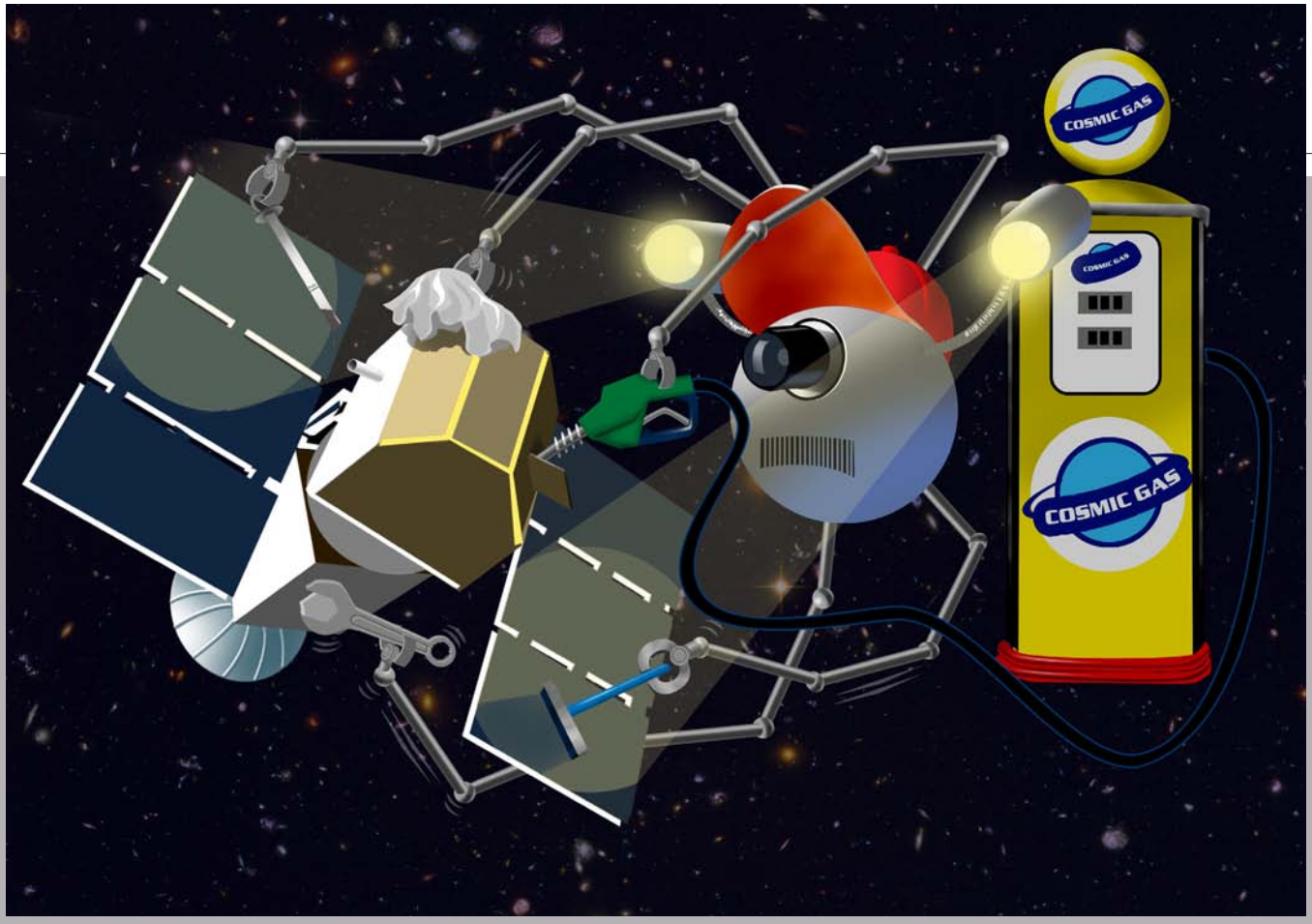

Shane Larson

SERVICE STATIONS IN SPACE?

On the world's streets there are millions of vehicles criss-crossing the globe every minute of the day and night. Thousands of repair shops are available to repair smashed fenders and run diagnostics to find out what electronic components need to be replaced or repaired, and perform annual maintenance tests, and issue registration renewal certificates.

It's much the same in space, where thousands of satellites orbit the globe and face potential collisions just like terrestrial vehicles. Satellite parts wear out and electronic systems get out of kilter. They need to be inspected.

"But, where's the satellite service station?" asks MAE's David Geller. Dr. Geller says he has always been interested in what he calls "orbital rendezvous," and this research is just a new application. "My previous research has involved guidance and navigation analysis and design for rendezvous and proximity operations. This is directly related to the current research."

The U.S. Air Force Research Laboratory funds Geller's research that began in October 2008 and runs for two more years. "The Air Force would love to have a satellite that can inspect and service other satellites in space," said Geller. "The point of the research is to find out if it can be done and how it can be done."

The project focuses on making a robot with the proper "guidance, navigation, and control systems," Geller explains. Essentially this means the robot could fly and maneuver without humans involved.

There are two big obstacles with the idea, Geller says. First is trying to teach a robot to fly and get good images of the satellites autonomously. The second is teaching the robot how to avoid accidental collisions with the satellites.

A lot of students are working on the project during the school year," Geller says. Participation is limited to graduate students because of the prerequisite classes needed to understand the research.

"I work pretty closely with Dr. Geller," said graduate student Mike Phillips. Right now, they are trying to shed light on how to approach satellites without damaging them and how to get the best images of the satellite depending on the position of the sun.

Phillips attends weekly meetings with Geller and other students where they discuss progress and problems, and they are assigned new tasks.

"The research I do for the project helps me with school work," he says, "because the two are very closely linked."

The project, officially known as Autonomous Quality Space Imagery for LEO/GEO Space Operations," is in its preliminary stages, Geller says. He adds that it will probaly be another 10-20 years before a "space service station" can become reality.

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Shane Larson

WINS UDOT INVENTORY CONTRACT

In 2007, *Creating Tomorrow* introduced you to "Aviation with an Algorithm," a breakthrough invention from Utah Water Research Lab (UWRL) and the Center for Self-Organized and Intelligent Systems (CSOIS). Small unmanned autonomous vehicles (UAV) fitted with computers gathered soil data to help farmers save precious water and money.

In 2008, *Creating Tomorrow* introduced the students from CSOIS who flew their $2,000 UAV to second place in national competition against $20,000 models from other universities.

This year, *Creating Tomorrow* heralds the Number One student team in the nation, as well as introduces several additional commercial uses engineers have created for the tiny airplanes. (Read about this team of winning ECE students in the department pages of this issue.)

Fondly known as AggieAir Flying Circus** (or AggieAir), these UAVs have already proven their worth in agriculture—sensing soil moisture and evapotranspiration rates to help farmers and canal operators take the guesswork out of water distribution. Now the computer sensors are being tweaked to look at Utah's highways.

The Utah Department of Transportation has contracted with the UWRL to inventory all 40,000 miles of roads in the state. Austin Jensen, a research engineer at the UWRL has earned the unofficial title of "General" as the manager of the resource center at the AggieAir. He's working to modify the UAVs cameras and sensors for the road work with CSOIS, mentored by Dr. YangQuan Chen—whose name you'll see again mentoring the student UAV champions. "General" Jensen says UDOT has never had a complete statewide inventory that includes signs, guardrails, and culverts. Plans are to have the sensors also pick up data on wetlands and noxious vegetation adjacent to roadways.

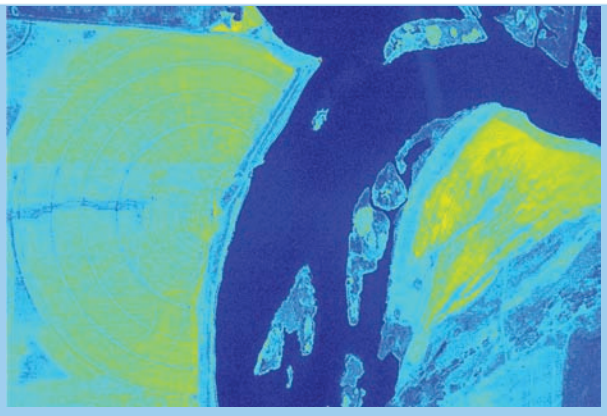
The point of the inventory is to help UDOT document and prioritize maintenance projects throughout the state. The point of using AggieAir is to save time, money, and manpower.

Not only are the UAVs cheaper than satellites and manned airplanes but they're more convenient. Satellites can take pictures only on their orbit schedule and of a much larger area than is useful to farmers or road maintenance officials, Jensen explains. The UAVs can be used at just about any time and cover some 30 miles in one hour with great resolution. Pictures are available immediately, while additional data are available as soon as the computers are downloaded and analyzed, Jensen adds.

"We can survey a small area easily within a day. The plane lands, we take the inventory, analyze it, and quickly get it back to the user. It can be updated more frequently because of its lower cost," Jensen says. "If they wanted a manned aircraft to do that it would be a lot more difficult and more expensive." The reason it's so much less expensive is because UAVs are built with bio-parts—parts bought off the shelf and put together at the water lab or in the CSIOS lab.

"We don't manufacture parts here, we just put them together. But we have written our own software so there is some custom stuff that we've done," says Jensen.

The only part that will soon be made at USU is the inertial measurement unit (IMU). Currently, the entire



Right: This is the near-infrared version of photos taken at 1,000 meters above ground level over some agricultural area and the Bear River, near Cache Junction. The visual spectrum image of the same area, taken at the same time, will come under another email. Left: The visual spectrum image of the same area, from the same altitude

THE NAME "FLYING CIRCUS" WAS FIRST USED IN 1917 BY MANFRED VON RICHTHOFEN—THE RED BARON AND COMMANDER OF THE JAGDGESCHWADER 1 TACTICAL UNIT—TO DESCRIBE THE BRIGHTLY COLORED AIRCRAFT THAT MADE THEM EASIER TO IDENTIFY IN A DOGFIGHT.

plane costs about $3,000 and the IMU alone costs about $1,700, Jensen explains. The new IMU, made here at USU (AggieNav), will not only lower the cost of the plane, but also improve flight performance with better sensors. There are errors still to be worked out on the UAVs, Jensen admits. "We are currently working at improving the accuracy of our imagery."

"General" Jensen says that work is also being done on a camera that views at different angles.

"Not only do we need a down-looking camera but we need a camera that turns and rotates 45 degrees so that it can read signs. That's the biggest thing that needs to be developed," says Jensen.

The UAVs are remote controlled and can be flown manually or autonomously, which is when the plane flies itself. Usually the UAVs fly on autonomous mode. Each UAV has a global positioning system and an IMU to navigate it to where it's supposed to go.

The platform for the project was developed by about 15 students—graduate and undergraduate—under the direction of Dr. Yangquan Chen at

THE NEXT STEP

Utah State University might have an unmanned aerial vehicle company in the near future.

Dr. Raymond Devito, Director of USU's Technology Commercialization Office, said he believes USU will have a UAV company within about a year. UAVs have many different capabilities and applications that various people and companies are interested in, said Devito. Utah's Department of Transportation is one of the clients USU currently is working with.

The sheriff in Washington County told USU's Mac McKee, Director of the Utah Water Research Lab, that he'd be interested in using the UAVs to look for illegal marijuana fields, Mckee said.

Devito said the UAV's can measure how much wind is in an area for potential wind-farm areas. They can also measure water usage and fish

"Those capabilities all open up a lot of potentially, commercially viable applications," Devito said.

Because USU doesn't currently have a company, it isn't marketing the UAVs, Devito said. The school gets all of its clients through word-of-mouth, he said.

Devito said the UWRL is in a good position to go out and get clients at this particular time.

"We're positioning it in a way where soon we'll have a mini-business within the water lab that has customers, that has operating procedures, that can be taken out to the outside world where somebody can grow it into a substantial business, " said Devito.

Devito said that despite having a company in a year or so, he felt it would be about three years before the company has the UAVs patented. This is because the office that does all of the patenting is very backed up.

CSOIS. Jensen helped develop the platform with this team of students when he was working on his master's degree in electrical engineering.

Ten students currently working on the project at CSOIS. They are Aaron Quitberg, Cal Coopmans, Chris Hall, Daniel Morgan, Haiyang Chao, Jacob Marsh, Long Di, Oscar Delgado, Ricardo Estevez, and Yiding Han.

Jensen says that working on the UAV is a great opportunity for students because it gives them great experience applying what they have learned or are learning and it helps them get jobs once they graduate.

As "the General," Jensen currently flies and builds the UAVs, manages the resource center, writes operating manuals and helps push the technology forward. However once AggieAir Flying Circus is up and running and has employees to build and fly the UAVs, Jensen will continue to manage it while focusing on development.

So far, the UWRL has only built one UAV. However, plans are to have six planes and three crews trained to fly them, says Jensen.

The UDOT $140,000 one-year contract begins in October, says UWRL Director Mac McKee. USU has given UDOT a flight demonstration and a pre-proposal.

"We're looking at precisely what it is we'll be able to do for them with the money they have," said McKee.

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THE DELIGHTFUL DILEMMA OF TOO MUCH WORK

A new 12,000 square foot hydraulics laboratory at the Utah Water Research Laboratory (UWRL) will greatly increase the amount of work that can be done, announces Research Assistant Professor Steven Barfuss.

"We're hoping the added floor space and flow capacity allows us to significantly increase our work load," Barfuss says. "In the past, we have had to deal with the dilemma of too many scheduled tests and research projects and not enough space or time to run them. With two hydraulics labs operating in parallel, we hope to keep up with requests for testing and estimate that we'll bring in another $1 million annually."

The UWRL is a stand-alone facility located near campus on the Logan River. It operates within an academic environment and collaborates with government and private sectors to address technical and societal aspects of water-related issues.

"There's a great interest in physical modeling as it is still state of the art with computer modeling being a secondary and less accurate tool," Barfuss says, adding that companies around the world request physical modeling at the Logan facility. The hydraulics laboratory at the UWRL performs many physical modeling projects for the U.S. Army Corps of Engineers, as well as a multitude of other clients from municipal, state and federal government and private engineering firms who also deal with hydraulic structure design problems," Barfuss notes, "That interest, and the growing volume of clients, is one of the reasons we decided to go ahead with the new building."

Much of what goes on in the new hydraulics lab will be testing scaled-down models of dams, spillways, intakes, and pump stations, in which the design of the structure is optimized to improve safety, constructability, and hydraulic efficiency. It is expected that the new building will also be used for performance testing large municipal control valves.

The building took about nine months to construct and was completed in May. Its estimated worth is close to $2 million dollars. The UWRL borrowed about $1.3 million from USU and the loan will be paid off over seven years using proceeds from projects performed in the new laboratory. No state funds were used to construct the new building.

The existing UWRL hydraulics laboratory has 50,000 square feet of floor space and a flow rate capacity of 230 cubic feet per second (CFS). The new hydraulics lab has a capacity of 110 CFS. The large flow rate capacities and the combined 62,000 square feet of laboratory floor space provide opportunities for hydraulic research that most other facilities in the country cannot achieve.

"People clamor to come here (UWRL) to test their products and to perform physical modeling because of the large flow rates we can provide," Barfuss says, adding that word is spreading about the expanded facilities and new clients are contacting the lab. "Satisfied customers tend to be our best advertising.

"Most of our work comes from word-of-mouth and most of our clients want to come back," says Barfuss. "When a new customer calls, it's very often at the suggestion of a client who is happy with our work.

"The Utah Water Research Laboratory's hydraulic laboratory is a premier laboratory in the world for what it can do—especially the sizes of models and tests that we can perform," the researcher adds. "Added benefits to the university include greater exposure of our facility, more projects for students and faculty to work on, and additional dollars."

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IRAQIS WORK ON WATER QUALITY ISSUES

Researchers at the Utah Water Research Lab (UWRL) have been working in the Middle East for decades, but in 2008, workshops to assist in initiating the revitalization of agriculture in Iraq began. Bethany Neilson, assistant professor in Civil and Environmental Engineering, made two teaching trips to the Middle East and will teach another group coming to campus in October.

The main goal of the training in January was to teach people in Iraq simple water quality concepts, says Neilson. "The idea was that they could use even the simplest tools to understand their instream water quality."

They taught the Iraqis to use Hach kits—small chemistry kits for measuring water quality constituents such as phosphorus, ammonia, or nitrate.

"Learning how to measure the water quality is good, but not enough," she notes. "In the second workshop we taught them different ways to model the movement of water and the water quality constituents in a river influenced by irrigation."

"The idea was to help them understand how their actions impact water quality downstream. Poor water quality not only affects human health, but also crop production and fisheries," Neilson says. "In the end, the goal is to try to help the Iraqi people produce more of their own food."

Neilson adds that cultural differences and the language barrier presented challenges. "When you speak through a translator, it's a challenge to make sure you present information clearly since you are stopping frequently to let the translator speak."

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COOPERATION CONTINUES IN MIDDLE EAST

Faculty members at the Utah Water Research Lab (UWRL) are taking the lead in water management and irrigation practices in a multi-university, multi-country proposal to improve the livelihoods of farmers in the Middle East. If funded, USU will review farming and water system operation practices in three agro-ecological zones in Egypt, Iraq, Jordan, Lebanon, Palestine, Syria, and Yemen with an eye on improving techniques that are likely to increase farm income.

The project is being assembled by the International Center for Agricultural Research in the Dry Areas (ICARDA) headquartered in Aleppo, Syria.

"I think we can help a lot in irrigated and rainfed eco-zones," says UWRL Director Mac McKee. "There's no one who can do a better job improving on-farm efficiencies; our guys are the smartest in the world on that. The same with system operations—getting water from the source to the field."

McKee thinks the approach may be quite different in the third eco-zone: the desert. Two thousand years ago in Nabataea [between present-day Syria and Jordan (Petra)] farmers were harvesting water from the desert to grow wheat. They etched small channels into the contour lines in the dunes to capture any water that fell.

"Maybe we can attach some modern techniques to a very old workable system," McKee thinks.

Seed funds to create the comprehensive study proposal are from the U.S. Agency for International Development.

"If funded, the project offers the United States a chance to be a player in a significant, positive effort in these Middle Eastern countries," McKee says. "Such an opportunity is welcome in this era when the United States desperately needs friends."

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Development Update

I've met with hundreds of alumni as I've traveled around the United States in the past years working for Utah State University and the College of Engineering. I've found a common love of USU and the experiences enjoyed from getting an education at this great institution in beautiful Cache Valley, and a deep appreciation for receiving a top notch education that has created excellent job and career opportunities.

The stories I've heard about fun experiences and successful learning opportunities alumni gained while at USU motivate me as I continue to pursue development efforts in the College of Engineering. In spite of a tough economy, we have had a very good year. New contributions to help fund student scholarships and student projects as well as facilities, and equipment, continue to be received.

With recent cuts in state funding, our development efforts and funding received from them are critical to our success in finding and retaining good students and faculty, and providing hands-on opportunities for our students. The growing student enrollment in the College of Engineering keeps us all excited about the future for our students. The assistance with our development effort that we receive from our alumni and from corporations and foundations. We greatly appreciate and need. As you may recall, our comprehensive campaign goal for the university is $400 Million, and runs through June, 2012. The specific goal for the College of Engineering is $30 million, and we are nearly half-way to achieving that goal.

This past year we have had numerous examples of generous people and organizations that have stepped up to help us in our mission. Some of the most impressive have been those who have made a commitment to help the college by creating a planned gift to leave their estate or other assets to the college, or by setting up a trust that names USU and the College of Engineering as beneficiary. This is an excellent way to strengthen USU and help ease a tax burden or settle an estate.

We appreciate those who have made ongoing pledges to the college, and who make yearly contributions to our annual fund through requests sent by phone or mail. These gestures of generosity make a real difference in what we do to better educate the engineers of the future.

We are grateful for the support we receive from our alumni and friends, including those friends who support us through their corporations and foundations. The future looks bright, and our hope for the future is in the hands of those we educate and prepare to take on the responsibilities of creating a better world.

Please get back to me with any questions you have about USU and the College or Engineering, and to let me know if I can help you in any way.

Sincerely,

Val Potter
Executive Director of Development
val.potter@usu.edu
435-797-8012

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MASSACHUSETTS ENGINEERING EDUCATOR LEAVES ESTATE TO USU

Albert L. Shane, a leader in engineering education and a 1968 graduate of Utah State University, is leaving the bulk of his estate to USU, permanently providing scholarship opportunities for future students in the Engineering and Technology Education Department.

Shane attended a vocational-technical high school and worked as a skilled technician for a number of years. In his mid-20s, he decided to go for a more advanced degree.

The first in his family to go to college, Shane earned his bachelor's degree in Industrial Teacher Education from the College of Engineering. A Philadelphia native, he chose USU after his first trip to the western United States.

Following graduation, he worked for the Ford Motor Company, Muskingum Technical College in Zanesville, Ohio, and the University of Michigan. He retired from Holyoke Community College in Holyoke, Massachusetts, where he taught electrical and computer technology and other associate degree-level electronics programs. During his career, Shane combined teaching with everything from advising management on new electronic components to designing custom peripherals.

When asked about the highlights of his career, Shane says, "I don't look so much at my career, as my education. Getting my degree at USU made all the difference in the world to me." Shane has many fond memories of his time spent at on campus. While many of his peers went to expensive, private colleges, he firmly states, "I went to Utah State University, and I never felt cheated."

Shane and his wife, Marion reside in western Massachusetts, where he is actively showcasing the rich industrial history of the area as a curator of the Museum of Our Industrial Heritage, in Greenfield, Massachusetts.

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